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Green Development and Investments in Science and Technology Policy: A Comparative Analysis of Developing Countries

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GREEN DEVELOPMENT AND INVESTMENTS IN SCIENCE AND TECHNOLOGY POLICY: A COMPARATIVE ANALYSIS OF DEVELOPING COUNTRIES

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ABSTRACT

Green development offers an attractive alternative to the resource-intensive growth pursued by today's developed countries; it allows development processes to be augmented with sustainable measures complementary to long term growth and STI policy investment may be ancillary to that. This paper seeks to answer the following two part question: How is the presence and strength of a country's national green development plan related to its investment in STI policies? And what role do historical, geographic, political, social, and economic factors play in explaining the adoption of such policies? A multi-level comparative analysis is used in this research to test the hypothesis that higher investments in STI will lead to stronger green development plans. Although the findings of this analysis suggest no direct correlation between the two variables, they do illustrate the importance of a variety of driving factors, particularly political ones, in leading to the creation of specific national plans for sustainable development.

ABBREVIATIONS AND ACRONYMS

CRGE	climate-resilient green economy
ENRAMED	Ethiopian Natural Resources and Environmental Metadata base
FDI	foreign direct investment
GDP	gross domestic product (nominal)
HDI	Human Development Index
ISI	import substituting industrialization
MDGs	Millennium Development Goals
NCS	national conservation strategy
NSI	national systems for innovation
R&D	research and development
SD	sustainable development
SDGs	Sustainable Development Goals
SDPRP	sustainable development and poverty reduction program
STI	science, technology, and innovation
STIP	science, technology, and innovation policy
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

ACKNOWLEDGEMENTS AND PREFACE

I would like to start by acknowledging my esteemed committee members: Professors Krister Andersson, Dale Miller, and Steve Vanderheiden. My gratitude and appreciation is without end and I'd like to thank each of you for your support, help, and guidance in the writing and development of this project.

As you know, this research has been part of a long process, starting over a year ago when I first decided to write an honors thesis. Although my specific research question has evolved quite a lot since then, it has always been focused around my interests in international sustainable development with an emphasis on the role of technology.

I am very pleased with the way that this research turned out and have all of you to thank for your suggestions along the way. You have my utmost respect as academics and mentors and it was truly an honor being able to work with each of you for the duration of this project.

I hope that this research may inspire new ideas from its readers and that it will serve to highlight the opportunities of sustainable development; I am humbled to be a part of the greater work on this important topic.

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INTRODUCTION

While development has traditionally been assessed by the amount of economic progress and growth made by a country, often measured by GDP, development scholars have been reshaping this characterization of development to include non-monetary factors that are more indicative of the quality of life that people lead. Emphases on other types and aspects of development focus on different factors than GDP, leading to the creation of alternative indices of development. The Human Development Index (HDI) for example, measures the health, education, and living standards, of people within a country in order to assess its development. Another component to more qualitatively assessing development is looking at environmental health in a country.

As global population and material consumption have increased over the years, natural resource stocks have become heavily strained, leading to declining ecological resilience and increasing environmental problems. This is especially true in developing countries where poverty puts people closer to such immediately felt environmental issues as soil deterioration, poor air and water quality, and sanitation problems. At the same time, the world has slowly come to the realization that resource-intensive growth has an impact on the global climate. This has caused countries of the developed world to begin pressuring those still in the process of developing into limiting their development-related, high resource-based emissions. Pathways to development are now the subject of wide debate since climate projections and scientists have indicated that if the developing world pursued the

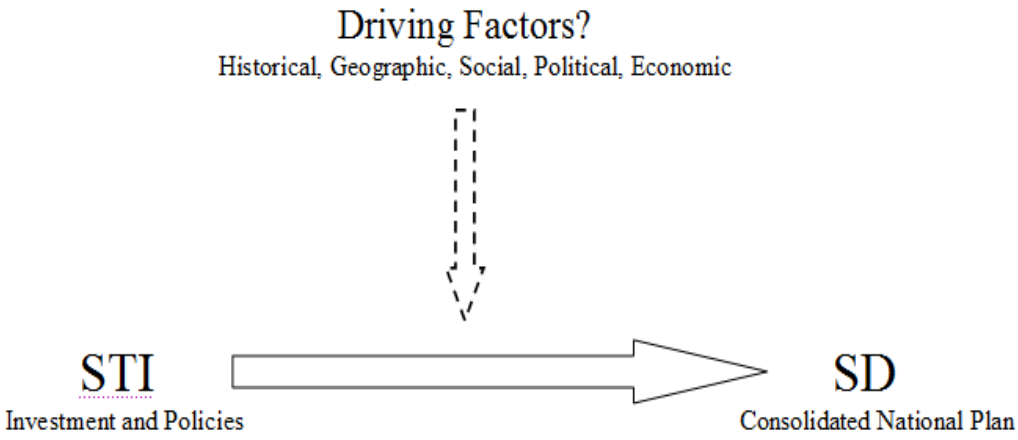
same high-polluting growth that was taken by earlier countries like the U.S., carbon emissions would soon be beyond controlling (World Bank, 2012).

Helpfully, green development offers an attractive alternative to countries seeking to augment their development processes with sustainable measures complementary to long term growth. Sustainable development is important because it seeks to address the ecological strains and associated problems caused by resource-based economies. Science, technology, and innovation (STI) policy investment may therefore be ancillary to this alternative characterization of development, especially because of the link between environmental improvement and poverty reduction.

The existing literature on this topic suggests that STI policies are critical to development—especially as studied in Africa—and that the focus of these policies may be shifting to sustainability topics (Wamae, 2008). Although STI policy literature acknowledges that the policy environment affects the quality of the resulting policies, what it does not cover, is what those contextual aspects may be.

Therefore, what I seek to answer by conducting a multi-level comparative analysis is the following two-fold question: Firstly, how is a country's decision to pursue or not pursue a national green development plan related to its level of investment in STI policies? And that being said, given varying levels of STI investment, can historical, geographic, political, social, and economic driving factors explain the strength or existence of national green development plans? Figure 1 provides a visual representation of how I believe these variables to be connected.

Figure 1



What I hypothesize, based on the connection I believe to exist between STI policies and green development plans, is that countries with higher investment in STI policies and systems are more likely to have stronger sustainable development plans than countries with lower levels of STI investment. Therefore, what I expect to see is a positive correlation between the level of STI investment and the strength of national green development plans. I hope to be able to explain this through an analysis of my five selected driving factors

Answering this question is important in providing insight into the development processes of the third world, specifically in regards to green development. Furthermore, this research will allow me to make scientific inferences about the processes that lead to sustainable development outcomes, such as increased investments in STI policies. My research can show if investing in STI helps to encourage green development in countries. I hope to identify patterns and to isolate which factors tend to be the more compelling deciders.

BACKGROUND

Sustainable development has been popularly defined by the Brundtland Commission as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Common, 1987). With natural resource stocks on the decline, both developed and developing countries around the world are realizing the importance of sustainable development and are beginning to transition their economies to meet demands in a less resource-intensive way. The United Nations has listed 'Environmental Sustainability' as one of its eight Millennium Development Goals, making one of the goal's targets to, "Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources" (Goal 7, 2010). Ban Ki-Moon, Secretary-General of the UN, highlighted the UN's emphasis on the importance of green development, saying:

> *"Prosperity need not come at the expense of our planet…wise investments in a greener, lower-carbon direction have tremendous potential to spur growth…and to move us forward in clean technologies, creating 'green' jobs…and preserving our planet's natural wealth"* (Ki-moon)

In fact, the UN has recently been transforming the Millennium Development Goals by creating the new Sustainable Development Goals (SDGs), which further support those values quoted by the Secretary-General and the direction that the world needs to move towards in order to sustain itself into the future (Sachs, 2012).

According to Jeffrey Sachs, a development economist and the UN Secretary-General's special advisor on the SDGs, "the SDGs are an important idea, and could help finally to move the world to a sustainable trajectory" (Sachs, 2012). These new

Sustainable Development Goals will attempt to address environmental issues that people face, especially in developing countries.

Although the topic of environmental sustainability in development has become a priority, as was previously introduced, the actual paths to development have been greatly debated.

The reason behind this debate has to do with recognizing justice issues between the two hemispheres—the global North, generally consisting of today's developed countries, and the global South, comprising of the less developed and still developing countries. During its development in the 1700s and 1800s, the North used a large amount of coal to fuel its factories during the industrial revolution; much of this development was very resource-intensive and produced new, suddenly higher levels of carbon emissions (Vaughan, 2009).

The North was able to make economic leaps forward at a low cost and it was during this time that society took off towards where it is today (Rostow, 1962). Since the industrialization of the North occurred before the realization of the effects of pollution on the environment, its development was unconstrained by worries about resource depletion, ecosystem imbalances, or climate change. Comparatively, parts of the global South and other portions of the less developed world, have now reached a point in their development where they hope to also achieve the sort of economic success and forward movement that the North did. With resources now more constrained than ever, and environmental understanding more pronounced, developing nations are being told that they cannot take the same resource-intensive

path to development as the North did due to the cost it would have to the global climate (Shen, 1997).

However, there are development scholars such as Wilfred Beckerman, who debate the 'right' of the developed world to force these restrictions on often impoverished countries just seeking to improve their current condition (1992). Developed countries are primarily concerned at the global scale in regards to climate change because they are geographically distanced from most of the physical environmental problems associated with a changing climate, such as sea level rise, increased droughts and desertification, and especially water accessibility issues. Therefore, developed countries seek to impose emissions restrictions on developing countries because they want to bring balance back to the climate and to mitigate climate change, since that is the part that they do experience (Beckerman, 1992).

For these developing countries however, reducing emissions to help mitigate rising CO_2 levels is not the top priority; they face more pressing environmental concerns, such as localized air and water quality, sanitation, and soil deterioration, which take precedence over regulating CO_2 emissions (Beckerman, 1992). These issues immediately affect the people living in environmentally vulnerable areas who are often impoverished and more likely to be affected by environmental hazards that affect their very livelihoods and well-being, than to care about their country's emissions reductions.

While focusing on national emissions would be the preference of the North, governments of countries in the developing world need to make choices that are concurrent with their own national interests. The choice therefore, is not for poor

countries to accept the imposition of the rich, developed countries or not, but is about whether greening their national policies makes sense for them politically and economically. While resource-intensive growth may actually make these countries worse off, even in the short run, green growth is more beneficial to both short and long term societal development goals.

Sustainable development that is ecologically and environmentally restorative needs to be pursued in these countries because it will address those previously listed issues while at the same time helping the country to move forward. For this reason, understanding the different pathways to development, especially sustainable paths, is particularly important.

Since every country is different, with unique and individual origins, histories, and current situations, a one-size-fits-all development policy is impossible to prescribe and each country must instead pursue its own particular path. Therefore, development can be seen as a learning process—as a country begins to industrialize it must learn new forms of institutional organization and governmental processes, as well as how to work new technologies into their existing economies and to build the supporting infrastructure to enhance those technologies (Niosi, 2010).

Although there is no one-size-fits-all development policy, there are generally three groupings of pathways that can generalize the paths that countries take in their development: 1) creating paths, 2) skipping paths, and 3) following paths (Niosi, 2010).

The strategy of creating paths involves developing human capital in order to increase innovation and output of domestic technologies. It is often an approach

used by middle-income countries that already have some ability to invest in human capital. However, it is also a good path for developing countries that have chosen to invest in STI policies since the focus on science, technology, and innovation in a country's industry would help it to move forward. Countries may also pursue a policy of Import Substituting Industrialization (ISI) through this approach, which although it works to develop infant industries, artificially distorts the country's comparative advantage, leaving them vulnerable when opened to the world market. ISI typically involves a high degree of experimentation with different industries, which although beneficial, can also be quite costly.

The second strategy, skipping paths, would be a good option in the case of developing countries; this would provide them with the opportunity to "technologically leapfrog" their way from dirty to clean economies (Morrison, 2010). Using this approach would cut costs for developing countries since they would be able to originally implement green, advanced technologies instead of incurring the costs of replacing older, dirtier systems (Morrison, 2010). Neoclassical economics has demonstrated that developing late can be beneficial because it allows those countries to catch up more quickly by obtaining those technologies from other, wealthier countries (Niosi, 2010). This approach also meshes well with STI investment since in order to adopt advanced, existing technologies, a country must first develop its capacity to acquire and use new knowledge (Wamae, 2008).

The strategy of following paths is the one that is most widely debated. As was previously discussed, this is the very core of the development debate—developing countries want to follow the same paths as countries such as the U.S., but the paths

they want to follow would be especially damaging to the environment at this point. For the global South to use a similar, dirty path to development as the North did, would greatly escalate today's existing environmental problems and strains to a point that the Earth may not be able to support, especially with the industrialization of such large populations in China and India. Although it is not completely just that the South must pay a higher price to catch up, this justice issue can be addressed through international climate finance schemes that can help in assisting developing nations afford and be able to industrialize more cleanly. Through donor-recipient relationships, developed countries and international organizations can work with developing countries to determine possible green development strategies.

International environmental sustainability has come to be pursued in different ways throughout the world, following one of two transformation patterns. Policy changes can be either incremental and occur over a long period of time, or may be rapid, changing quickly (Niosi, 2010). As no two countries are the same, it is impossible to assign a 'one-size-fits-all' development formula, which is why it is especially important that each country finds its own, unique combination of policies and sectors that will be most effective in achieving green development goals (Niosi, 2010). For this reason, international organizations cannot play too large a role in financing or mandating environmental change and must therefore work to incorporate national differences into any policies that they suggest. Although policy specifics must coalesce with the countries they are enacted in, the literature shows that STI is a good focus.

It is therefore important to understand why countries choose the policies that they do in pursuing or not pursuing green development. Policies that work well in one country may seem like they would work in another; however, for various reasons, they may not be attempted, and it is important to understand what factors and underlying drivers may result in governments foregoing the implementation of certain types of policies.

The literature review portion of this thesis will summarize the components of STI policies and green development plans. By reviewing existing policies within countries, I will demonstrate if there is a plausible connection between the level of investment in STI policies and the potential drivers behind the creation of national green development strategies.

SUMMARY OF RESEARCH

An analysis done by Watu Wamae (2008) shows that, "STI is important in the development process in Africa." In the African case, the research finds that some of the focuses of existing STI policies are agriculture and health, suggesting that the opportunity for STI research to be correlated with environmental topics may be a significant option (Wamae, 2008). Wamae supports this by describing that there has been a move in the direction of "more sustainable research and policy activities" (2008).

Other studies, such as one by the African Forum on STI, support the findings of the Wamae analysis that STI is critical in helping developing countries to "implement sustainable solutions to such pressing development challenges as food security, clean energy, clean water…, and economic development" (2012).

Furthermore, what these findings show is that STI policies play an integral role in fostering the growth of connections "between knowledge, values, socio-economic environments, society, and institutions" (African Forum, 2012).

Additionally, the work of Calestous Juma finds that there is a "unique opportunity for Africa to lead in adopting low-carbon growth strategies" (2009). Like many of the other studies on STI and its application in Africa, Juma's work focuses primarily on agriculture. However, Juma also discuss the potential of using existing technologies as solutions to providing clean energy in Africa and suggests that the adoption of new technologies through STIP can help countries leapfrog to a clean economy (Juma, 2009).

The literature also shows that the STI policy environment determines the quality and applicability of the research produced (Wamae, 2008). The National Systems of Innovation (NSI) approach emphasizes the importance of developing a holistic understanding of the relationship between the actors and activities involved (Wamae, 2008). Therefore, it is essential to consider the many factors that influence a country's investment in different policies and its pursuit of a national green development plan as a means to sustainable development. These factors include historical, geographical, political, social, and economic aspects.

For example, understanding the historical context of a country's development helps in interpreting why or why not certain policies are or have been pursued. In Africa especially, many countries were previously colonized by European powers and today different degrees of the evidence of that colonization still exist (Michigan, 2013). Looking at the historical context also includes analyzing

the successes or failures of preceding policy measures and how they influenced a country's development.

In looking at geographical factors, it is important to consider the resource endowments of a country and how they relate to any resource specific policies or problems. This will also affect the demand and pressure on those resources for everyday use since abundant resources may be the ones most exploited and in collapse. It is also necessary to look for indications that a country may have experienced the symptoms of a Resource Curse or Dutch Disease situation.

Political drivers are also important to consider. Studies find that STI research in Africa has been limited by frequent institutional turnover and governmental change (Wamae, 2008); this indicates that political stability is especially important. Other growth strategy analysis papers site that a "predictable political environment, rule of law, low corruption, strong institutions, and a conducive business environment are prerequisites for growth" (IMF, 2012). For example, governmental type and structure affects the ease of getting things done in a country, like passing legislation and making policies. For people exposed to environmental problems, governments that are better representative and accountable to their people are more likely to be responsive to the needs of the people and to the necessity of making structural changes that will increase sustainability. Additionally, policy sequencing plays a role in the adoption of policies because preceding policies may affect the likelihood that later, future policies, will be passed or successful. In terms of development strategies, how a country proceeds forward depends on whether it has an existing plan or whether it will be creating a new plan. This affects how new

policies will be incorporated into a plan and how environmental goals are ranked compared to other development goals.

Apart from political factors, social ones also play a role in a country's decision of the importance to pursue a green development plan. The social capacity must exist for people to accept the structural, institutional, and behavioral changes that will come with the implementation of such a policy. Additionally, social stability, culture, and the openness that people have to new knowledge, will have an affect on this as well.

Lastly, economic factors play a large role in determining if the creation of a green development plan is a viable course of action to pursue. If the benefits of implementing and following a green development plan outweigh the costs, then a country will almost certainly head in the direction of sustainable development. However, this is where the appropriability of returns becomes especially important since it reflects the ability of the people and governments to realize the value of improved environmental outcomes and resource use. Markets and economic conditions within a country are also important since openness to trade, a free market, and macroeconomic stability will attract more investment and therefore more opportunities for innovation and growth. Also important to consider in terms of the economic factors influencing national green development plans are the opportunity costs since an investment in sustainable development is a tradeoff from an investment in something else.

METHODS

In order to answer the question I am posing, my comparative analysis will focus on the drivers of and investment in STI policies as they relate to countries' green development plans.

To draw conclusions from my research, I will do a comparative, multi-level analysis of developing country case studies. So that I can compare the different driving factors behind a country's decision to pursue or not pursue creating a national green development plan in relation to its investment in STI policies, I will choose countries that are fairly similar. Holding at least a few factors constant will provide a benchmark by which to compare the differences in investment and development policy. Additionally, having this baseline will help in my analysis of the role that historical, geographical, political, social, an economic factors play. For example, although I will be analyzing geographic factors, I will limit their effect by constraining my case studies to one region, Sub-Saharan Africa.

Another way that I will attempt to limit noise in my findings and overcome potential problems of reverse causality is by leveraging longitudinal data. Although I am hypothesizing that STI investments are what leads to the implementation of national green development plans, this argument is particularly vulnerable to reverse causality because the relationship could easily be the other way around. For instance, without specifically testing for the order of the relationship, my findings could potentially be the reverse, showing that STI investment is actually the result of a good national green development plan.

Therefore, since the causal criteria specify that the cause must come first and that the cause must be observed to co-vary with the effect, using longitudinal data will allow me to apply a temporal perspective to the data that should resolve any questions of reverse causality (Fitch, 2012). Looking at trends in the data, such as the sequencing of STI investments compared to national green development plans and comparing the trends in order of occurrence, will make this research design more robust and less vulnerable to reverse causality and other problems.

Keeping this in mind, in my selection of case studies, I will firstly look at countries with varying levels of investment in STI policies, classifying each country's investment as low, medium, or high. This ordinal classification will be developed by comparatively assessing the percentage of GDP that each country spends on research and development. By creating an ordinal scale for investment, I will be able to roughly quantify investment as low, medium, or high, therefore decreasing the subjectivity and arbitrariness of assigning these levels. For clarification, as is listed in the proceeding 'Assumptions' section of this paper, there is no 'zero' level of STI investment being analyzed. Although it is good to consider this level, it is omitted because it would be unrealistic to include and likely would not have any impact on my actual analysis. Since countries typically have a least a minimal level of investment as a result of financing for research and development, there would be no representative case for the 'none' level. I will use the World Bank's World Development Indicators database to collect the country data for R&D investment as a percentage of GDP.

After choosing countries to use as case studies based on their STI investment level, I will secondly determine if the country has a national green development plan and consider the strength of that plan, again determining its strength on a low, medium, and high basis.

Unfortunately, for this classification there is not a clear way to assign the strength of the resulting green development plan. Other studies have shown that "indicators of sustainable development are not available…and institutions have been grappling with the development of sustainability indicators for a long time…currently there are no monitorable sustainable development indicators" (EPA, 2012). This illustrates that there is no perfect or existing way to measure the strength of the development plans I will be analyzing.

Interpreting the relative successes of each plan, the country's recent growth, and the state of each country's environment and people represents one possible approach to quantifying the strengths of country's plans. Data on how much money a country allocates to its green development plan would be ideal in determining the strength of the plan; however, background research indicates that as a whole, national green development plans do not necessarily have a monetary amount associated with them for direct budgetary allocation. Instead, these plans are often facilitated through multiple governmental agencies, suggesting that a good way to quantify plan strength would be by counting the associated programs and agencies within each country. Therefore, in order to code the strength of each plan, I will use a relative scale to compare the policies, frameworks, strategies, and plans between the countries.

Next, I will assess which driving factors, historical, geographical, political, social, and economic may have played a role and to what degree in the investment of those STI policies and how they may explain the presence, absence, and strength of any green development plans. Table 1 gives a visual representation of how these case studies will be quantifiable.

Table 1

	Level	Country	Strength/Existence of a National Green Development Plan	STI/SD Policy Year	Drivers
Investment in STI Policies	Low				Historical Geographic Political Social Economic
	Low-Medium				Historical Geographic Political Social Economic
	High-Medium				Historical Geographic Political Social Economic
	High				Historical Geographic Political Social Economic

In addition, my methods will include making several assumptions which my argument will be based upon.

Assumptions

For the purpose of this paper I will assume the following:

1. That countries seek to develop, through both the growth of their economies and investment in human capital and potential for innovation

2. That green development can and will improve the lives of people through the enhanced stability of natural resource stocks and the environment
3. That people will realize the value of improved environmental outcomes and resource use
4. That a healthy environment transcends economic value to the point that it becomes intrinsically valuable to the people who depend upon it
5. That countries have at least a minimal level of investment in STI policies as a result of research and development financing and that no country has absolutely zero STI investment in STI

Definitions

STI policies, sustainable development, and growth are key themes throughout this paper and as such, it is essential to distinguish and define clear meanings of each that is being investigated.

Development: I will use development in a more holistic sense than the traditional definition of development as purely economic growth; I define development to be an improvement in the lives (well-being, health, environment, community, economic, etc.) of people within a country and therefore the country as a whole. In terms of measuring this sort of development, measures such as the Human Development Index would be more appropriate than the standard measure of GDP.

'Sustainable' or 'Green' Development: In this paper I will use the terms 'sustainable development' and 'green development' interchangeably to mean the same thing. I will use the popular definition offered by the Brundtland Commission to describe sustainable development as "development that meets the needs of the present

without compromising the ability of future generations to meet their own needs" (Common, 1987). Furthermore, I will use these terms to describe the ways through which countries seek to the lives of their citizens as they pertain to a healthy and productive environment; that is to say development goals that relate to the environment. Additionally, it is important to note in this definition the three pillars of sustainable development: social, economic, and environmental.

National Green Development Plan: This is the dependent variable that I am analyzing in this paper. In context to this research, I am defining a national green development plan to be the policy mechanism through which sustainable development principles and frameworks are consolidated.

Growth: In this paper, I define growth as: measurable increases of a given unit or index.

Technology: For the purpose of this paper, I will discuss technology, specifically green technology in terms of increases in efficiency that result in less consumptive uses of natural resources. My focus will be on innovative developments that can help drive sustainable measures and target environmental issues.

STI policies: I interpret STI policies as those that create frameworks for science, technology, and innovation to be studied and implemented into socio-economic development policy.

Research and Development: I use R&D to represent the processes of idea generation and technology creation that go into developing STI policies. Specifically, I assume the role of R&D to be the creation of new knowledge about scientific and

technological topics for the purpose of discovering preferred and more efficient ways of moving forward in a given domain, sustainable development in this case.

DATA

The complete, raw data set of Sub-Saharan countries and their corresponding investment for R&D as a percentage of GDP can be found in Appendix A. This data indicates that of the 48 countries classified as being in 'Sub-Saharan Africa,' only 15, about a third of the countries, had available information on what percent of GDP is put towards R&D. This could mean one of two things: 1) that the data simply isn't available, or 2) that those countries do not spend money on R&D. Since the distinction between these two possibilities is uncertain, for the purpose of clarity, these cases will be ignored in my analysis based on the assumption that if they actually did have zero expenditures in R&D as a percentage of GDP, then it would be listed as zero instead of nothing at all.

For the countries that did have reported R&D expenditures, the average was 0.34% of GDP, which is actually the same percentage spent by Zambia. As seen in Table 2, this number is bolded and is also the median for the 15 point data set of reporting countries. Table 2 also shows where the low, medium, and high investment levels for R&D were placed. As is evident in the table, most of the countries were clustered around the average and median of 0.34, ranging from 0.2 to 0.41. The investment level cutoffs were determined by this cluster and by the location of the main gaps in the data. For example, there was a large gap between Madagascar at 0.13 and Burkina Faso at 0.2, as well as between Sudan at 0.41 and Botswana at 0.52. Although there was also a sizeable gap between the three

countries at 0.2 and Mauritius at 0.32, my preference was to keep the data and investment level categories symmetrical around the average at Zambia of 0.34.

Table 2

	Country	R&D Expenditure (% of GDP)
LOW 0-0.19	The Gambia	0.023
	Lesotho	0.03
	Madagascar	0.13
MEDIUM 0.2-0.49	Burkina Faso	0.2
	Ethiopia	0.2
	Mozambique	0.2
	Mauritius	0.32
	Zambia	**0.34**
	Seychelles	0.38
	Uganda	0.38
	Senegal	0.39
	Sudan	0.41
HIGH 0.50+	Botswana	0.52
	Gabon	0.6
	South Africa	0.93

(Trading Economics, 2012) (World Bank, 2013)

In order to select countries for each of the investment levels, I collected information on which countries had systems for STI policies in place. Since finding the percent of GDP spent on R&D was simply a way to operationalize and determine levels for STI investment, this was a particularly important step in analyzing the data. My findings were that the Gambia, Lesotho, Madagascar, Burkina Faso, Ethiopia, Mozambique, Mauritius, Zambia, Seychelles, Uganda, Senegal, Sudan, Botswana, Gabon, and South Africa all had dedicated STI systems in place, meaning that I would be better able to gather information from these countries in my analysis.

Because Lesotho was the only low investment level country that had STI systems, I chose it as my first case study. For the medium level, I decided to choose two case studies since that level was the largest in terms of the number of countries falling into its cluster and range. The two countries I chose were Ethiopia and Zambia; both were chosen since they also had STI systems. Another reason for choosing Zambia is because as the average case for R&D investment at 0.34, it is more representative. Additionally, Botswana was chosen for the high category due to its existing STI systems. Table 3 throws a summary of the data for the four countries selected. The bolded words in the 'Drivers' column show those factors that best described why each country did or did not have a consolidated national green development plan.

Table 3

	Level	**Country**	**Strength/Existence of a National Green Development Plan**	**STI/SD Policy Year**	**Drivers**
Investment in STI Policies	Low	Lesotho	No plan, country's national development plan has promising, medium strength SD initiatives	2006/2012	**Historical** Geographic **Political** Social Economic
	Low-Medium	Ethiopia	Strong, high strength, dedicated plans: "National Conservation Strategy" and the "Climate-Resilient Green Economy Strategy"	1993/1992	Historical **Geographic Political** Social **Economic**
	High-Medium	Zambia	No plan, country's national development plan has unconsolidated low strength SD initiatives	1996/2006	Historical Geographic **Political** Social Economic
	High	Botswana	Medium-high strength plan: "Poverty-Environment Initiative"	1998/1997	Historical **Geographic Political Social Economic**

ANALYSIS

This section discusses the possible driving factors behind the connection between the level of STI investment and the presence and strength of a national green development plan for the four countries chosen. For the full comparative country profile data on historical, geographic, social, political, and economic factors for Lesotho, Ethiopia, Zambia, and Botswana, see Appendix B.

Case Study 1: Lesotho

Based on its R&D expenditures of 0.03% of GDP, Lesotho was chosen to represent the low level of STI investment. It has no specifically designated or consolidated green development strategy, but its national development plan has promising, medium strength sustainable development initiatives.

Background

Lesotho is a small country located in the South of Africa that is completely surrounded by the country of South Africa. While its climate is classified as temperature, it is subject to periodic droughts even though water is one of its most abundant resources. However, models show that due to climate change, in the future Lesotho will experience "higher temperatures and more erratic rainfall patterns" (IMF, 2012). As a country that relies heavily on rain-fed agriculture, Lesotho's social and economic development is particularly threatened by climate change.

Lesotho's STI work is largely facilitated through its Ministry of Communications, Science and Technology; however, the Inter-Ministerial Committee on Science and Technology, as well as the Lesotho Advisory Commission

for Science and Technology, and the Lesotho Innovation Trust Fund are also significant entities in the mission of furthering the development of STI policies in Lesotho (Masin, 2010). The main document through which Lesotho's STI policies are expressed is *The National Policy on Science and Technology 2006-2011 of Lesotho*. The focus of this policy is to increase Lesotho's institutional research and development capacity (Masin, 2010).

Although Lesotho does not have a dedicated national green development plan, its National Strategic Development Plan is focused on goals that will provide opportunities to place the country on a path to sustainable development. Among its strategic goals are:

1. Pursue high, shared, and employment-creating growth
2. Develop key infrastructure
3. Enhance the skills base, technology adoption, and foundation for innovation
4. Improve health, combat HIV and AIDS, and reduce vulnerability
5. Reverse environmental degradation and adapt to climate change
6. Promote peace, democratic governance, and build effective institutions

(IMF, 2012)

As indicated by Goal 3, Lesotho is clearly dedicated to increasing their investment in the factors of STI; however, that this is a goal also reinforces that their current level of investment in innovation and technologies is low.

Similarly, Goal 5 demonstrates Lesotho's commitment to pursue their development in an environmentally friendly way. This section of their National Strategic Development Plan discusses the need to "consolidate the national climate change strategy and agenda," highlighting the absence and need of a comprehensive national green development plan (IMF, 2012).

Lesotho's progress in terms of the environmental sustainability of its development can also be assessed by their advancement in achieving Goal 7 of the MDGs. According to a 2009 Millennium Development Goals Report for Lesotho, Goal 7: Ensure Environmental Sustainability was rated as 'probably' for the prospect that it would be achieved by 2015; 'probably' was the middle of three prospect ratings with the highest being 'potentially' and the lowest being 'unlikely' (UNDP, 2009). A more recent MDG progress report for Lesotho, published in 2011 by the UNDP, indicates that there is "slow progress" on this goal (UNDP, 2011). The report further explains that the reason for this slow progress is because of a variety of specific environmental challenges faced by Lesotho.

With 86% of the labor force involved in subsistence agriculture, one of Lesotho's main environmental problems has been soil erosion and degradation (CIA, 2008). This has also been due to overgrazing as well as to people settling in marginal areas, putting pressure on the natural landscape, which has led to a soil loss ratio on arable lands of 30-40t/ha/year as compared to the global average of 1t/ha/year (UNDP, 2011).

However, despite these issues, Lesotho is particularly well suited for pursuing various directions of green development in accordance with their investment in STI policies.

Historical

Lesotho was originally a colony of Great Britain, gaining its independence in 1966 (CIA, 2008). Having developed in parallel fashion to South Africa, which it is highly economically tied to, has both helped and hindered Lesotho's development

over the years. It is possible that being too historically dependent and reliant on South Africa's progress has slowed Lesotho's own path forward and may have hampered its creation of a sustainable development plan.

Geographic

As a country, Lesotho is particularly well situated to harness various forms of green energy such as wind, solar, and hydro (UNDP, 2011). Know for its abundance of water in the highland region, Lesotho has very well developed hydro power initiatives. However, much of the water from the highlands is exported to South Africa, providing revenues that have been essential to the country's economic development (World Bank, 2011). The lowland regions of Lesotho suffer from periodic droughts and additionally, the garment industry, which represents Lesotho's largest export commodity, is largely dependent on water (World Bank, 2011). This has led to an especially great need to enact policies that will regulate water use and distribution in Lesotho, resulting in the creation of the Highlands Water Project and the Metolong Authority. Unfortunately, the dams built under the Lesotho Highlands Water Project have displaced many subsistence farmers living in those areas.

Because Lesotho is so well situated in terms of access to renewable energy, especially in the form of hydropower, it is surprising that they have not created a national green development plan to specifically strategize and plan for the enhancement of these sources as the country continues to grow and demand a higher supply of energy. Currently, Lesotho is able to produce roughly 90% of its electrical power needs (CIA, 2008); as the country continues to grow it will need to

expand this supply. However, many rural household still rely on biomass fuel which has increased local environmental problems, so providing renewable sources of electricity to this portion of the population needs to be addressed and would be able to if the country were to create a strategic national green development plan (Masin, 2010).

Adopting a low carbon development route would help Lesotho in a variety of ways. For example, using renewable sources would mean lower energy costs and the saved money could be put towards making the country more competitive in other areas (IMF, 2012). Also, it could give Lesotho the opportunity to begin exporting electricity elsewhere in the region; this is a potential of about 6,000 MW of wind power and 4,000 MW of pumped storage, plus 80 MW of hydropower (IMF, 2012). Solar and wind energy schemes in Lesotho are still in the early stages, which makes it even more critical that if Lesotho wants to benefit from this fairly untapped export industry, they will need to have a strategic plan for doing so. Developing the solar and wind energy sector would also be a good replacement for the biomass fuel being currently being used by rural households that are not as connected to the electricity grid (IMF, 2012). Lastly, by further developing its renewable energy sector, Lesotho may have the potential to gain access to international climate finance or to carbon credit programs.

Because there is so much untapped potential due to geographic and resource factors for Lesotho to really create a sustainable development plan that would benefit its environment, people, and economic growth, it is unlikely that this driver is a reason that they do not currently have such a plan.

Political

In the case of Lesotho, political reasons are perhaps one of the most compelling as a potential driving factor to why there has been no substantial movement in the creation of a national green development plan. While the government of Lesotho acknowledges that this represents a major hole in their development planning which needs to be accounted for, the problem is that existing policies are fragmented; therefore, the delivery on these policies and plans has been weak as well.

Specific issues endemic to Lesotho in this case are that efforts have been duplicated due to institutional fragmentation and overlap, that there has been weak implementation and enforcement of the actual policies and legislation, and that governmental and private efforts have not been coordinated well (IMF, 2012).

However, the Environment Act of 2008 did move Lesotho in the direction of incorporating environmental issues into national planning (UNDP, 2011). This act requires that an Environmental Impact Assessment be submitted before any major work is started. Additionally, while the focus of the current National Strategic Development Plan is poverty reduction, the primary objective of the 1996/97-1998/99 Plan was to enhance sustainable development. Today, decision-makers in the government are required to go through trainings about the importance of considering environmental impacts (UNDP, 2011).

Social

Although Lesotho has a very high literacy rate of almost 85% and an abundance of labor, the unemployment rate is a high 45% (CIA, 2008). There is a

predominance of low-skilled jobs in the industrial sector which may suggest that some of the more educated part of the population is underemployed. Additionally, brain-drain into South Africa and other larger economies has been cited as a possible source of why there is limited high-end technical skill and knowledge in Lesotho.

With so many people in Lesotho relying on their natural surroundings for subsistence agriculture and their livelihoods, it is especially important for the country to focus on sustainable development that will maintain and enhance the natural capital of Lesotho (IMF, 2012). Because of this, it is unlikely that social factors are a central reason why Lesotho has yet to create a dedicated national green development plan, especially since the population is so well educated.

Economic

Lesotho has a small, open economy, which is especially influenced by external factors, both on a global and local scale. Since as a country it is entirely surrounded by South Africa, the economy of Lesotho is closely tied with that of its neighbor. As was previously mentioned, Lesotho exports a large share of its abundant highland water to South Africa, for which it receives equally large and essential revenues. Another source of revenue tied to South Africa that Lesotho relies upon, is customs duties from the Southern Africa Customs Union; these account for the majority of government revenue (CIA, 2008). In addition to this, remittances from miners working in South Africa also contribute to Lesotho's economy.

Although Lesotho is very closely tied, both geographically and economically with South Africa, it is interesting that it does not have better STI policies since South Africa had the highest R&D expenditures as a percentage of GDP at 0.93 while Lesotho's was almost the first lowest at 0.03%. Therefore, economic driving factors do not very well explain the absence of a national green development plan in Lesotho, especially since the country has so much to gain economically in terms of improving their technological development of widely available renewable energy sources as a sustainable path forward.

However, Lesotho's proximity to South Africa, one of the largest economies in Africa may hinder its growth to a degree. Because so much of the country's revenues come from custom's revenues and remittances, investment in other areas has not been as high since much of the economy is focused on interactions and services provided between Lesotho and South Africa. It has been argued that Lesotho is not exploiting its ties with South Africa as much as it should (Masin, 2010). These reports suggest that since South Africa is the largest economy on the continent and also the most advance in STI, Lesotho should work with South Africa to enhance its own NIS systems (Masin, 2010).

Summary

Based on this analysis of possible driving factors behind Lesotho's fragmented sustainable development policies and lack of a national green development plan, it appears that historical and definitely political driving factors are the most likely reasons that the country has yet to implement a consolidated plan for sustainable growth.

Case Study 2: Ethiopia

Based on its R&D expenditures of 0.20% of GDP, Ethiopia was chosen to represent the low-medium level of STI investment. In terms of the strength of its national green development plan, Ethiopia has a National Conservation Strategy (NCS) that led to the creation of a very strong, dedicated Climate-Resilient Green Economy Strategy (CRGE) that is the main strategic focus for the country's pathway to achieving sustainable development.

Although Ethiopia's NCS strategy was adopted a year before its National Science and Technology Policy of 1993, I do not think that this poses a problem in my research in terms of reverse causality. The NCS strategy was a response to the 1992 Rio Conference but wasn't really a strong or effective policy in itself—in particular, its focus was conservation, not specifically green development. The more notable of Ethiopia's green development policies, namely the CRGE strategy, wasn't implemented until 2012, well after the National Science and Technology Policy and other, more medium strength initiatives that happened in the meantime, such as the SDRP, were in 2002, still after the National Science and Technology Policy.

Background

Since the 1990s, the Ethiopian government has been focused on including poverty reduction and human development measures into the country's development policies (MoFED, 2010). With the creation of the UN's Millennium Development Goals, the country further saw an opportunity to enhance its own development planning by basing their revised development policies off of the MDGs (MoFED, 2010). Because the MDGs are so "well placed in the national development

context of the country," Ethiopia has made progress in the direction of the MDGs as a result of this political commitment (MoFED, 2010). A 2010 MDGs report for Ethiopia shows that the country is likely to be on track to achieve Goal 7: Ensure Environmental Sustainability if it continues to address the challenges it notes in its development analysis (MoFED).

Of developing countries globally, Ethiopia is one of two, the other being Cambodia, that has really sought to include green growth measures into its major economic and national development strategies. Following the 1992 Rio Conference, Ethiopia created a National Conservation Strategy (NCS) and later a national environmental policy in 1997 (EPA, 2012). These policies are what originally catalyzed Ethiopia's move towards implementing sustainable development principles, later leading to the creation of the country's National Development Policy Framework, institutional framework for sustainable development, Sustainable Development and Poverty Reduction Program (SDRP) in 2002, and lastly the landmark Climate-Resilient Green Economy (CRGE) strategy in 2012 (UNDP, 2013) (EPA, 2011).

Together, these policy frameworks and strategies serve as a very strong example of a country that has innovatively integrated sustainable measures into many levels of its development goals.

Ethiopia's CRGE strategy for developing its green economy is based on the following four pillars:

1. Improving crop and livestock production practices to increase food yields, hence food security and farmer income, while reducing emissions
2. Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks

3. Expanding electric power generation from renewable sources of energy fivefold over the next five years for markets at home and in neighboring countries
4. Leapfrogging to modern and energy-efficient technologies in transport, industry, and buildings

(EPA, 2011)

These pillars, especially numbers three and four, demonstrate an emphasis on STI-related policies that the country will be pursuing as part of its CRGE strategy. However, considering its currently fairly low investment in R&D, Ethiopia seems to have a long way to way to go if it wants to expand its technological capacity for renewable energy and incorporating energy efficiency into existing and new infrastructure.

Because Ethiopia is classified in my research as the low-medium level of STI investment, the corresponding strong level of its national green development is unexpected based on my hypothesis of increasing investment, increasing strength. Therefore, analyzing which of the potential driving factors are possibly responsible for this is especially important for case study of Ethiopia to be better understood.

Historical

Unlike the rest of the African continent, Ethiopia is the only country that has remained independent over the years and was never under the control of a colonial power (CIA, 2008). Until 1974 it had a longstanding tradition of monarchy, which ended however when Emperor Haile Selassie was overthrown in a Marxist military coup (Freedom House, 2012). This next, military regime was again ended by another coup 1991, with the country being taken over by a rebel group called the

Ethiopian People's Revolutionary Democratic Front (EPRDF) (Freedom House, 2012).

Without the basis of colonial rule that was present in the rest of Africa, it is possible that some of Ethiopia's history of political unrest and coups may be a result of the country not having any colonial institutions from which to base its own.

Geographic

Ethiopia is very geographically different from the other three case studies being observed in this research; many of these differences being attributed to its location in Eastern, as compared to Southern Africa. For example, although drought is common throughout Africa, Lesotho, Zambia, and Botswana only experience it periodically, while in Ethiopia droughts are considered frequent (CIA, 2008). Additionally, it is geographically unique in that it has 430,000 barrels of oil proved reserves as compared to the other three countries, which report zero (CIA, 2008).

A further difference is that of the four countries being investigated as case studies in this research, Ethiopia is significantly the largest with a total area of 1,119,683 sq km (CIA, 2008). Among other geographic variants includes climate, which is considered tropical monsoon.

Ethiopia is also distinctive in that it is the location of the Great Rift Valley, a geologically active divergent plate boundary that is highly susceptible to earthquakes and volcanic eruptions (CIA, 2008). This geological endowment of Ethiopia has contributed to its potential to generate renewable energy through geothermal power. Other forms of renewable energy abundant in Ethiopia include hydro-electric, wind, and solar—positioning Ethiopia to potentially become an

energy exporter in the Eastern Africa region. These sorts of renewable energy sources are essential to Ethiopia's Climate-Resilient Green Economy strategy and to furthering its goals of economic and sustainable development. Furthermore, they represent a sector that should be a focus of STI policies, propositioning the question of why Ethiopia has such low investment in STI considering its relatively untapped potential to capture a share of the regional energy market. Although the country has such a high capacity to increase its production of renewable energy, its hydroelectric power generation is only 41% (MoFED, 2010). However, Ethiopia has goals to increase its hydroelectric output fivefold in the next five years in order to "decouple its economy from the fluctuating prices and unsustainable nature of the oil-based world," according to its CRGE strategy (EPA, 2011).

Another issue, drought, poses a serious environmental problem in Ethiopia. In 2011, one of the worst droughts in the history of the region hit Ethiopia at the same time that over 270,000 refugees were fleeing into the country from famine in Somalia (Freedom House, 2012). This left roughly 5 million Ethiopians in need of food assistance in addition to the Somali refugees (Freedom House, 2012).

Other problems include deforestation, caused primarily by overgrazing and agricultural expansion, which has resulted in soil erosion, flooding, and increased desertification (CIA, 2008) (MoFED, 2010). As a biodiversity hotspot with many endemic species, deforestation poses a major threat to Ethiopia especially since coffee is one of those endemic species. The clearing of Ethiopian rainforests, which are home to many species of wild coffee, jeopardizes the unique and potentially commercially valuable coffee diversity that grows there (McKee, 2007).

The country has also had problems with water shortages in areas where farming is more water-intensive.

The variance of these geographically-related factors as well as well as environmental problems in Ethiopia suggest that they could be a critical driving force behind Ethiopia's creation of a national green development strategy. Because the country is so large and varies in climate, terrain, and resources, the need for a comprehensive green development plan is likely more necessary.

Additionally, the dependence on agriculture, involving 80% of the labor force and comprising 47% of GDP, means that the country and people are particularly affected by shocks to the agricultural sector (CIA, 2008).

Political

Countries bordering Ethiopia, such as Somalia and Sudan, as well as Ethiopia itself, are rife with political and social problems. In addition, Ethiopia has had boundary conflicts with Eritrea that have further raised tensions in the area and have led to accusations of terrorism, triggered guerilla conflict in 1883, and a territorial war between the two countries from 1998-2000 (Freedom House, 2012). Although Eritrea was awarded the disputed territory, the two countries have been in contestation ever since then.

Political instability is often related to lack of foreign direct investment (FDI) in a country because investors do not feel guaranteed that their investment will be safe or protected if there are changing or volatile political regimes. As was previously introduced, studies have found that STI research in Africa has been negatively affected by frequent institutional turnover and governmental change

(Wamae, 2008). Therefore, it is likely that this may be one reason that Ethiopia has relatively low levels of investment in STI policies. However, it is also possible that the very reason Ethiopia has such a strong green development strategy despite low levels of STI investment, is because of the centralized and authoritarian nature of its government.

Although Ethiopia is considered a federal republic, recent turmoil in the country has led to it being downgraded from Freedom House's 2001 classification as being 'partly free' to 'not free' in 2012 (Freedom House). This has been due to "the government's increased use of antiterrorism legislation to target political opponents and opposition movements" as well as to the large degree of corruption amongst government officials (Freedom House, 2012).

Since the country's second coup in 1991 that placed the Ethiopian People's Revolutionary Democratic Front in charge, there has been an EPRDF presence at all levels of society and government. The leader of the party, Meles Zenawi, has continuously ruled the country since then, transitioning between head of state and prime minister in controlled elections (Freedom House, 2012). The EPRDF has cemented its control in the country by monitoring and controlling oppositional politicians.

However, because Ethiopia's government exhibits authoritarian characteristics, this may actually be helpful it in terms of making progress in the creation of environmental laws. Although a more representative type of government would be more responsive to the needs of people suffering from environmental ills,

there is still something to be said for the command and control style of mitigation that authoritarian governments can exert.

For example, Ethiopia was recently able to make significant progress in consolidating data from the multiple governmental entities in charge of environmental and natural resource protection and decision-making in order to facilitate the finding of relevant information. This has led to the creation of the Ethiopian Natural Resources and Environmental Metadata base, called ENRAMED, which is an Amharic expression meaning "Let us walk together" (Getaneh, 2005). This expression is particularly fitting in light of the goal of the metadata base—to form a partnership for cooperation and dissemination between the various institutions involved. ENRAMED synthesized data from the seven major environmentally-related federal institutions in Ethiopia including:

- The Ministry of Water Resources (for water)
- The Ministry of Agriculture (for land, forest, vegetation, crops and livestock)
- The Geological Survey of Ethiopia (for minerals and stones)
- The National Meteorological Services Agency (for climate)
- The Environmental Protection Authority (for environmental data)
- The Ethiopian Mapping Authority (for geo-spatial data such as maps, satellite images, etc.)
- The Ethiopian Science and Technology Commission (a multi-sector institution covering all natural resources from a specific technology development point of view)

(Getaneh, 2005)

Because no one institution covers or controls all information within the country on natural resources and the environment, this metadata base has solved information retrieval problems that would otherwise restrict decision-making and make progress more difficult (Getaneh, 2005).

Social

Social reasons are an unlikely reason that Ethiopia has had such success in the creation and implementation of its Climate-Resilient Green Economy strategy or for its failure to invest more in science, technology, and innovation policies. Because refugees and the illicit drug trade contribute to the social situation in Ethiopia, if anything, social reasons should have resulted in a political environment that would have been unfocused on addressing sustainable development; as has been illustrated in other sections of this analysis, this has not been the case for Ethiopia (CIA, 2008).

However, a social factor that may have influenced the government's focus on sustainable development is the degree of poverty in Ethiopia. Of the countries being studied in this comparative analysis, Ethiopia has the lowest GDP per capita at $700 USD per person (CIA, 2008). Since poverty reduction was one on the initial goals of Ethiopia's development planning, this social factor may have played a small role in the country's creation of the Climate-Resilient Green Economy strategy, which is a pathway to improving well-being within the country.

Furthermore, the literacy rate is a low 42.70%, which suggests a low technical skill base and a possible reason why Ethiopia has such a low degree of STI development (CIA, 2008).

Ethiopia also has a very diverse population in terms of ethnic and religious groups. The primary division is between Oromo and Amara people, comprising of 32.1% of the population and 30.1% respectively (CIA, 2008). However, another ethnic group, the Tigrayan, has been favored in economic and political matters by

the government (Freedom House, 2012). On a religious dimension, 60.8% of the country is Christian while another 32.8% is Muslim (CIA, 2008). Although religious freedom is guaranteed by Ethiopia's constitution, there have been growing tensions over the year since these religious divisions exist on a mostly ethnic level. Together, these ethnic and religious differences have been a source of conflict within Ethiopia that has led to some of the political unrest in the country.

Economic

Ethiopia has had a fairly troubled economy over the years. In 2001, it qualified for debt relief from the Highly Indebted Poor Countries initiative and in 2005 Ethiopia's debt to the IMF was forgiven (CIA, 2008). Because the Ethiopian economy is very dependent on the agricultural sector, which accounts for 47% of GDP, it is highly vulnerable to shocks caused by climate change-related drought (Getaneh, 2005). As was previously mentioned, drought is a frequent and prominent environmental problem in Ethiopia, severe enough that in drought years, GDP is observably decreased. A 2002 drought experienced by the country resulted in a 3.3% decline in GDP, for example, which highlights the degree to which the Ethiopian economy is dependent on the land and agriculture (CIA, 2008). However, the years since 2003 and 2004 have shown impressive, sustained economic growth, reporting an average of more than 11%; these trends indicate that the macroeconomy in Ethiopia is beginning to stabilize (MoFED, 2010).

Because environmentally-related conditions, namely drought, affect the Ethiopian economy so harshly, economic factors are a very likely reason for Ethiopia's creation of such a strong sustainable development plan. A study by

Ethiopia's Environmental Protection Authority found that "green growth will have an impact on around two-thirds of the economy," which shows how much the country has to gain from such a focused CRGE plan (EPA, 2011). Not only this, but the nomenclature used in the plan's name itself: Climate-Resilient Green Economy strategy, indicates that the focus is on forming a green development strategy around climate-related economic issues.

Summary

Based on this analysis, it seems that the most compelling driving factors for why Ethiopia is atypical of the pattern I hypothesized are geographic, political, and economic; some social factors may have played a role as well but not to the same degree that these others have.

Case Study 3: Zambia

Based on its R&D expenditures of 0.34% of GDP, Zambia was chosen to represent the high-medium level of STI investment. In terms of green development, Zambia lacks a dedicated national strategy; however, its overall national development plan does have some promising, albeit low strength sustainable development initiatives included.

For this case study, it is important to again mention that of countries in sub-Saharan Africa reporting R&D expenditures as a percentage of GDP, 0.34%, Zambia's investment represented both the mean as well as the median amount.

Background

Zambia is a landlocked country located in Southern Africa. Among the environmental problems it faces are air pollution and acid rain in the mineral

extraction and refining region, chemical runoff into watersheds, poaching of various animal species, deforestation, soil erosion, desertification, and lack of adequate water treatment (CIA, 2008). Although Zambia's environmental problems are fairly extensive and seem that they should suggest a robust plan for sustainable development, their progress towards implementing any sort of related measures into its strategic policies has been slow and unfruitful.

Zambia does have some sustainable development initiatives in place in its 5th National Development Plan, implemented in 2006, and has made slight progress towards putting together a sustainable development framework. The Vision 2030 plan is also one of the country's more significant development documents outlining possible strategies. Additionally, the Environmental Management Act of 2011 is one of the policies in place in Zambia that has attempted to integrate sustainable development principles into its framework. Also cited as positive achievements in the direction of sustainable development are: "the integration of some aspects of SD into national poverty strategic plans, diversification of the economy away from copper, and promotion of sustainable land management" (Zambia, 2012). However, so far these efforts have only been made at the planning level and have not been implemented much or at all, particularly due to a lack of enforcement and absence of institutions that would specifically carry out those goals (Zambia, 2012).

Zambia's Science and Technology Policy Act was enacted in 1996, with some of its focus areas being on agriculture, health, energy, and mining—topics that have tried to be addressed in the country's attempts at integrating sustainable development measures into its other policies.

According to Zambia's 2011 MDG progress report, "significant reforms and investments are still required" before Goal 7 is to be achieved; the report further states that "with this state of affairs, it is unlikely that Zambia will attain MDG 7 by 2015" (Chiwele, 2011). Clearly the lack of a consolidated green development plan has not been helping Zambia's chances of achieving the MDG goal of Ensuring Environmental Sustainability.

Historical

Zambia was formerly a colony of Great Britain until 1964; during this colonial era, Britain left local rulers in charge and only indirectly administered the colony. However, later in the 1920s when copper was discovered, many Britons and Europeans came to the country to work as technicians (BBC, 2012).

The transition to independence in Zambia was fairly smooth; however the first president of the country, Kenneth Kaunda attempted to remain in power and the constitution had to be changed in 1996 to bar him from future elections (BBC, 2012). An attempted coup in 1997 led to the politically-charged hearings and sentences of the soldiers involved—an issue which wasn't fully resolved until 2005 (BBC, 2012).

Additionally, due to droughts and refugees coming from the Democratic Republic of Congo, Zambia during the 2000s has had to request food aid in order to prevent rioting.

It is probable that the high-medium level of STI investment in Zambia is a result of the European technical influx after the discovery of copper in the country.

However, historical factors alone are not likely to have had an impact on the failure of the country to create a national green development plan.

Geographic

Geographically, Zambia is characterized by high plateaus with some hills and mountains (CIA, 2008); it is fairly resource rich, which is one of the reasons that it is an overall net exporter. Its natural resources are primarily earth minerals including copper, cobalt, zinc, and lead; other resources include coal, emeralds, gold, silver, uranium, and some oil (CIA, 2008). Mining therefore plays a large role in the extraction and processing of these resources and has been a major source of localized air and water pollution, as well as chemical runoff (Zambia, 2012). In the use of these and other resources in Zambia, it is clear that and environmental and sustainability component has been lacking in the existing development plan since industries such as mining have not efficiently maximized or coordinated their output strategy.

Another environmental problem, deforestation, has further exacerbated problems associated with the country's climatic-related droughts. The deforestation rate has been high, but decreasing in Zambia with the forest loss dropping from 66% in 1990 to 55.9% in 2007 (Chiwele, 2011); however, this number percentage of forest loss is still high enough to be concerning. Reports on the state of deforestation in Zambia therefore discuss that protecting forests from further degradation is essential to forwarding the goals of a resilient green economy (Chiwele, 2011).

Deforestation in Zambia is primarily driven by over-exploitation of forests, conversion to farmland, fires, and clearing for wood fuel (Chiwele, 2011). A study

from Zambia's Environment Outlook Report shows that in rural areas in Zambia, 95% of the population uses wood fuel, while in urban areas, 90% use charcoal (Chiwele, 2011). The country's RIO+20 report states that "Zambia must reduce the deforestation rate to ensure a green economy and sustainable development," highlighting the significance of addressing this aspect of environmental degradation within the country (Zambia, 2012).

In order to reduce people's dependence as wood and charcoal as fuel sources, Zambia can use its relatively higher investment in STI to help development renewable energy sources, of which Zambia has a wide range. By investing more in hydropower, solar, and wind energy for example, Zambia would be able to provide these off-the-grid areas with clean energy sources, which would decrease deforestation and resulting emissions, as well as make air quality in those areas less polluted.

Based on this analysis of the geographic factors adding to Zambia's environmental problems, it does not likely that geographic determinants are responsible for the country's lack of a green development strategy. Because addressing deforestation is so critical in reversing a large variety of environmental hazards and in forwarding sustainable economic development, yet there has not been any improvement or significant policies created to mitigate those losses, then geography cannot be said to explain the absence of such a strategy.

Political

Political reasons play a large role in Zambia's lack of having a strong, consolidated national green development strategy. Although there are seven

prominent government agencies that deal with environmental and developmental issues, one of the problems is that they are not coordinated well enough. While most countries have similarly distributed agencies and institutions dealing with a range of environmental topics, their interactive structure is often more consolidated or at least facilitated through a national policy or strategy. This is something that Zambia does not have, which results in the existing seven entities not being able to effectively cooperate with each other to create any sort of meaningful progress towards sustainable development.

Not only are these governmental divisions not well connected with each other to work together and not create conflicting policies, but they are also inadequately funded and under-staffed—resulting in even less impact on the ground (Zambia, 2012). For example, one report quantifies that "out of the 544 positions at technical and professional levels at the Forestry Department, 390 positions are filled" (Chiwele, 2011). The report goes on to further point out that Zambia's Environmental Council, which enforces regulations, isn't fully representative since it only has members from four of the country's ten provinces (Chiwele, 2011). This limited representation in the body that enforces national environmental policies suggests that even if Zambia were to create a consolidated green development plan, that it would not be implemented successfully or well.

The lack of funding and of adequate staff to fill the necessary positions in these agencies is likely a factor of low political will to actually see progress in these areas. Although poverty is one of the largest issues faced by Zambia, it is inexplicably linked to environmental issues and those of sustainable development

so they should not be ignored in favor of other problems. Furthermore, considering Zambia's medium-high level of STI investment, this suggests that there is some sort of communication failure between STI experts and politicians.

Social

Literacy rates in Zambia are fairly high, at 80.60% considering low education expenditures as a percentage of GDP, which are only 2%, the lowest of the four countries being studied in this analysis (CIA, 2008). However, technical skill is not particularly high and could be a reason that even though there is high STI investment, the knowledge gained has not been adequately translated or disseminated into a working sustainable development plan.

Additionally, of the four countries being focused on in this research, Zambia has the lowest life expectancy, at 38.63 years, which is likely linked to the high levels of poverty in the country (CIA, 2008). A low average life expectancy affects productivity and output by resulting in higher employee turnover such that efficiency is decreased due to having to train new employees more often.

The population is relatively homogenous in terms of ethnicity but for religion, it is split between Christian, comprising of between 50-75% of the population, and Muslim and Hindu, comprising of between 24-49% of the population (CIA, 2008). A split like this could result in religious conflict, however, in Zambia there has not been much of a history of this between the Christian population and the Muslim and Hindu part.

Additionally, in 2000, as many as 60,000 refugees from the Democratic Republic of Congo fled into Zambia in less than a week. Absorbing refugees could

have had large impacts, such as on the existing culture within Zambia, however the impact was primarily related to emergency provisioning during that time and did not seem to have any affect on Zambian culture, STI investment, or perspectives on sustainable development.

It is possible that social drivers can in a small part explain Zambia's lack of sustainable development initiatives; however, I do not think that it is a very strong case based on this analysis especially since so many people are impoverished and therefore very open to sustainable development or any other form of development that might increase their level of well-being.

Economic

Zambia's economy is largely affected by the productivity of the country's mining sector and the global demand and price for the resources it produces, such as copper. An overall net exporter, 64% of its exports are from mined resources, primarily copper and cobalt (CIA, 2008). Although only 6% of the labor force in Zambia is involved in industry, this sector constitutes over a quarter of GDP (CIA, 2008).

Recently, due to the decreased output of the mines in Zambia's Copperbelt, environmental degradation and deforestation have increased (Chiwele, 2011). With national unemployment now at 50%, many ex-miners and other unemployed people have turned to farming and charcoal production, which has led to the encroachment upon and settlement in the forests along the Copperbelt (CIA, 2008) (Chiwele, 2011). That 85% of Zambia's labor force is involved in agriculture may be a reflection of this miner-to-farmer transition (CIA, 2008). Further highlighting the effect of

economic conditions resulting in job losses and unemployment on Zambia's attempts at integrating sustainable development is the following quote from the country's report to the Rio+20 Conference on Sustainable Development, "unemployment leads to the unsustainable exploitation of natural resources important for a climate resilient and low carbon economy" (Zambia, 2012).

While unemployment causes increases in environmental degradation, similarly does poverty, which is inarguably linked. In rural parts of Zambia, poverty is particularly high—in these areas "the livelihoods of many rural poor are intricately linked with exploiting fragile environments and ecosystems" according to the same Rio+20 report (Zambia, 2012). This illustrates that in Zambia, any sustainable development measures need to be coupled with efforts to address poverty and reduce unemployment.

However, other economic factors in Zambia do support a move towards sustainable development. For example, Zambia has been considered the 6th best country in Africa in which to do business, which has been helpful in attracting FDI (Chiwele, 2011). It is possible that the higher levels of FDI in Zambia may be related to the country's comparatively greater investment in STI and associated policies.

Although economic driving factors related to the mining industry, unemployment, and poverty appear to have large impacts on the condition of the environment in Zambia, they do not satisfactorily explain why the country lacks a consolidated, focused, and effective sustainable development strategy. Considering how much these factors drive environmental degradation in Zambia, it is surprising that the country does not have a clearer plan for addressing them. While many of

the country's reports on sustainable development mention and identify this flaw, there has been very little movement in the direction of creating a national strategy that would attempt to focus on them. Therefore, economic factors must be dismissed as a likely contributing factor to why Zambia doesn't have a better green development plan.

Summary

Among reasons listed in Zambia's RIO+20 report for why sustainable development initiatives have failed to take hold in the country are: "the absence of an appropriate SD framework, high poverty levels, poor SD coordination, inappropriate indicators, and poor funding of relevant institutions" (Zambia, 2012). These correspond with my finding that political reasons, specifically the lack of political will, characterized by the under-funding of relevant institutions, is the likely driving factor behind Zambia's failure to create a strong, green development plan.

Case Study 4: Botswana

Based on its R&D expenditures of 0.52% of GDP, Botswana was chosen to represent the high level of STI investment. In terms of its sustainable development plan, Botswana does indeed have one, which I am classifying as medium strength.

Background

Botswana is a landlocked country located in Southern Africa; with not particularly hospitable climate and terrain in the first place, it will face significant challenges with the onset of climate change-related environmental problems. Projections mainly forecast that rainfall will decrease in the coming years, which

will greatly affect people, natural resources, and ecosystems within the country (Botswana, 2010). Because fresh water is already limited in the country, this suggests that there will be even more extreme water scarcity issues that the country will need to address through managed and contemplated sustainable development

According to Botswana's MDG progress report, there is a strong supportive environment for Goal 7 that has led to its targets being classified as either 'likely' to be achieved or already achieved (Botswana, 2010). This is in large part due to the coordination of efforts between Botswana's Vision 2016, the National Action Plan, and the National Poverty Reduction Strategy. Commonly referred to as "Vision 2016," this main plan is formally called the "Long Term Vision for Botswana: Towards Prosperity for All." Implemented in 1997, Vision 2016 uses five national principles to align seven goals with the MDGs—MDG Goal 7 for example, is aligned with Vision 2016's Goal 2: A prosperous, productive, and innovative nation (Botswana, 2010).

In order to aid in the dissemination and cooperation of information between these multiple development strategies, Botswana is creating an Environmental Information System to "track and capture information from different data providers" (Botswana, 2010). This will facilitate the sharing of information and break down barriers between the governing agencies that would otherwise act as obstacles in achieving cooperation and progress.

Historical

Like many of the other countries in my analysis, Botswana was formerly a colony of Great Britain, gaining its independence in 1966 (CIA, 2008). One of the

country's challenges has been to maintain a closed border to the "thousands of refugees from Zimbabwe who are fleeing economic collapse and political persecution" (CIA, 2008). Additionally, there has been longstanding debate amongst its neighbors over the plan to build a bridge across the Zambezi River at the short Botswana-Zambia border (CIA, 2008). However, due to the nature of these historical conflicts, it is not likely that they have influenced the creation of Botswana's sustainable development plan.

Geographic

Botswana has a semiarid climate with rolling tableland and the Kalahari Desert in the southwest part of the country. It is generally ill-suited for agriculture, with less than 1% of the country being arable land, resulting in Botswana having to import most of its food and making food security a major issue. With limited fresh water sources, periodic droughts, occasional dust storms, and expected decreases in rainfall due to climate change, this is likely to become an even greater and costlier problem in the future—and conservation will become especially important in Botswana. Geographic reasons in this case, are a very strong indicator of why the country has seen the necessity to create a green development plan.

The scarcity of fresh water in Botswana both now, and in the future, affects many people and the country in many other areas as well. The water sources of many rural communities cannot handle prolonged drought. According to one of Botswana's reports: "large sections of the population depend directly on biological resources for their survival and livelihoods" (Botswana, 2010).

Drought and water scarcity will affect the entire ecosystem in Botswana as well as those other resources that people are dependent on. For example, drought will hurt the growth of forests and since wood is responsible for 98% of energy in rural areas and 79% in urban areas, people's access to energy will be greatly affected (Botswana, 2010). Due to this high degree of dependence on wood for energy fuel, deforestation in Botswana has been tied to a lack of access to other sources of energy.

Overgrazing and desertification are two other issues that have fed into this vicious drought-related cycle that is degrading the environment in many parts of Botswana. Pastoral farming has led to the degradation of eastern rangelands in Botswana because farmers are raising more cattle than is sustainable for the area (Botswana, 2010). This may have to do with the types of land tenure that Botswana uses—while state held land, representing about a quarter of all land in Botswana is mostly set aside for national parks, forest reserves, and cities, communal land is used for "grazing, crop production, game reserves, and wildlife management areas," calling to mind a very similar situation to Garrett Hardin's "Tragedy of the Commons" allegory (Botswana, 2010). Freehold land, accounts for a small percentage of land in Botswana is also used for livestock farming.

The aforementioned environmental and geographically-related problems are very probable reasons for Botswana's implementation of a consolidated plan for sustainable development.

Political

Listed as 'free' compared to the other countries being studied in my analysis, which were considered only 'partly free' by Freedom House's rankings, political factors and the fact that the government is therefore more representative of its people likely played a role in the cooperation of forming a national green development plan (Freedom House, 2012).

Social

Botswana has a fairly high literacy rate of 81.2%, which has played a large role in the success of the country's environmental education initiatives (CIA, 2008). A part of Botswana's sustainable development planning, the established Environmental Education Committee has revised the National Environmental Strategy and Action Plan, as well as worked to increase public awareness and knowledge about the environment and sustainability issues (Botswana, 2010).

However, despite this high degree of public outreach and education on sustainability topics, environmental monitoring has been challenged due to a shortage of analytical skills (Botswana, 2010). To combat this monitoring problem, Botswana's Department of Waste Management and Pollution Control has created a team of "Green Scorpions" to act as an environmental patrol, help with compliance, and promote good practices (Botswana, 2010).

HIV/AIDS infection rates in Botswana are the reported to be the second highest in the world, which threatens the human and social capital being built upon in the country (CIA, 2008).

Another social component, religion, is interesting to compare in Botswana to the other three countries being studied in my analysis. While they were largely

religious, Botswana has a significant amount of the population, over 20% that reports 'none' as their religion (CIA, 2008). Whether this plays a direct or indirect role in the country's environmental policies and the behaviors of its citizens is hard to say, but many religions do emphasize some sort of stewardship or reverence towards nature that would be lacking for this portion of the population.

Considering the high level of literacy in Botswana, it appears that social factors have been a driver in the creation of the country's green development plan since it demonstrates a high social capacity for people to accept the structural, institutional, and behavioral changes that have come with the implementation of this policy.

Economic

Of the countries being studied in this analysis, Botswana has the highest GDP/capita by quite a lot, at nearly $15,000 (CIA, 2008). Additionally, since its independence in 1966, Botswana has maintained one of the highest economic growth rates in the world; reports even state that "two major investment services rank Botswana as the best credit risk in Africa" (CIA, 2008). However, since diamond mining accounts for more than a third of GDP and between 70-80% of exports earnings, the country is also particularly vulnerable to economic crises on the international level since the most recent crisis for example, resulted in a loss of income from diamond sales (CIA, 2008) (Botswana, 2010).

Since Botswana has such a poor climate for food production, its economy is not as dependent on agriculture as others. Instead, Botswana's GDP composition by

sector represents that industry at 51.5% and services at 46.9% are the major sources of income (CIA, 2008).

Botswana's economic base on natural resources could be one of the reasons that it has created a national green development plan. This sort of plan is highly necessary for the country considering that sustainable management of those natural resources is essential in order to maintain the economy's current success. Therefore, economic factors are a probable driving factor behind Botswana's green development initiatives.

Summary

Based on this analysis, it seems that the most compelling driving factors behind Botswana's creation of a medium strength, consolidated green development plan are geography, political, social, and economic.

Comparison and Trends

Lesotho, representing the low level of STI policy, although it did not have a specifically dedicated plan for green development, had medium strength strategies in place in terms of sustainable development initiatives that were present in other national policies of the country. Next, Ethiopia with the second lowest level of STI investment, falling into the low-medium category, was surprising in that it had the strongest green development plan, taking the form of a "Climate-Resilient Green Economy Strategy." Zambia, the country with the next highest level of STI investment, which was also the average and median for countries in Sub-Saharan Africa reporting R&D percentages, both lacked a consolidated plan and had the weakest sustainable development measures in place elsewhere. Finally, Botswana,

the country that was classified to represent the high level of STI investment, had a medium strength green development plan.

While Lesotho's lack of STI investment and corresponding lack of a green development plan fit with my hypothesis, the sustainable development initiatives it had included in its general national development plan were medium strength. The case of Ethiopia certainly did not fit my hypothesis since it had a strong, high strength dedicated plan to green development; however, Ethiopia should be considered an outlier because it is globally noted to have one of the best sustainable development plans. Although Zambia did not have a dedicated plan, unlike Lesotho, it didn't have much of a commitment to sustainable development through other channels or its general national development plan. Botswana, representing the highest level of STI investment had a green development plan that had medium-high strength.

There was one driving factor that was identified as being important for each country in this analysis: political factors. Political reasons, specifically institutional overlap were found to be a likely reason in each case why the countries had or had not implemented a consolidated national development plan.

There is an additional trend from this data and analysis that is worth noting though: both Ethiopia and Botswana, the two countries that had specific plans in place for addressing sustainable development also had some sort of environmental database or information system in place for sharing such knowledge between related agencies within their country's governments. Lesotho and Zambia, the two countries that did not have their own dedicated sustainable development plans

lacked a cooperative database like this and it was found that the political overlap between various agencies working on environmental-related issues was a problem for consolidating information into a workable plan. This may suggest a possible connection between environmental databases and information-sharing and the creation of a sustainable development plan.

There are also two other potential trends this data may suggest and that are important to consider. Firstly, although my research hypothesized that a sustainable development plan was the causal result of investment in STI policies, both Ethiopia and Botswana, the two countries that did have such a plan, actually had national STI policies that were implemented one year after their sustainable development plans. Whether this implies reverse causality of the variable is unclear given the limited size of my study to only four countries. However, considering that Lesotho and Zambia had sustainable development plans that weren't implemented until 6-10 years after their respective STI policies, this may suggest that the closer the two types of policies are implemented to each other, the more successful they may be.

Secondly, another interesting similarity to notice between the two countries that did have sustainable development plans, is the fact that in addition to both of them having political factors in common, it was also found that geographic and economic factors had been important in the creation of their national green development strategies.

CONCLUDING REMARKS

Unfortunately, this research does not particularly highlight the benefits of investing in STI and national innovation systems in terms of achieving or setting a

strategy for sustainable development. My hypothesis that higher levels of STI investment would mean stronger national green development plans is therefore not supported by this data.

It is important to note that the four countries being studied, although they were classified on a scale of low to high investment in STI, this scale had a very small range. With Lesotho representing the low level of STI investment with only 0.03% of GDP spent on R&D and Botswana representing the high level of investment at 0.52% of GDP, this equates to a difference between the high and low ends of the scale of only 0.49%—less than half of one percent. To base this range off of an amount that equates to less than half of a percent gives some question as to the validity of my method for scaling investment level in STI policies between Sub-Saharan countries. To offer a brief comparison to where this range fits on a global scale, R&D spending in the United States for example is 2.79% of GDP (World Bank, 2013). It is therefore possible that if I had used a different metric to classify the STI investment level and if I had then selected different countries to use in my comparative analysis, that I might have found different or more conclusive results.

A further problem with using R&D as an indicator for STI investment as it pertains to sustainable development is the fact that for some countries, a large portion of R&D spending is military or defense-related and may have nothing to do with green development or technology. Although military-based innovation, research, and development has sometimes led to everyday technological implementation in the public and private sectors, it cannot be assumed what portion

of a country's R&D expenditures are actually contributing towards improvements in sustainable development-related STI.

An additional issue with generalizing my results to any trend is that since I used detailed case studies to analyze what particular drivers may explain deviations or articulations of the hypothesized trend, *n* in this research was limited to four. With a higher *n*, my results would have been more conclusive to the extent that I would be able to say with more certainty whether or not they are consistent with a given trend.

And finally, there is the possibility that both of the variables being tested, STI investment and green development plans are actually endogenous. Having two outcome variables would suggest that there is some other factor causing these investments and policies. Therefore, potential dual endogeneity is a very problematic concern that shouldn't be ignored when interpreting this data and needs to be considered if any additional research on this topic is to be conducted.

As it is, there is very little indication from my results that there is a correlation between level of STI investment and strength of a national strategy for sustainable development. Therefore, my conclusions can only remain tentative until further research is conducted on this subject to supplement my results and findings. However, my research still remains as evidence that historical, geographic, political, social, and economic factors play major roles as potential drivers in sustainable development and related initiatives; particularly, political factors since in all four of the case studies this was a key driver of either the existence and strength of sustainable development policies.

QUESTIONS FOR FURTHER RESEARCH

While the implications of my research are somewhat limited because it only focuses on four cases studies, a good direction for future research would be to supplement these finding with the further study of other sub-Saharan countries in Africa that also had reported numbers for percentage of GDP spent on R&D. Similarly, this research could be expanded by using a different indicator for STI investment level other than percentage of GDP spent on R&D. A possible alternate indicator could be the percentage of the population employed as researchers or in the technology and development industry. Yet another could simply be the strength of the STI policies and plans of these countries, using similar metrics of analysis as I used for classifying the strength of the countries' national green development plans.

Conducting more research, especially in a purely quantitative form, on the relationship between STI policies and green development would be helpful for development agencies by further indicating whether increased investment in STI policies can lead to stronger plans for sustainable development.

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APPENDIX

Appendix A

Complete data set of Sub-Saharan African countries and investment for R&D as a percentage of GDP:

Country	R&D Expenditure (% of GDP)		
Angola	-	Malawi	-
Benin	-	Mali	-
Botswana	0.52	Mauritania	-
Burkina Faso	0.2	Mauritius	0.32
Burundi	-	Mozambique	0.2
Cameroon	-	Namibia	-
Cape Verde	-	Niger	-
Central African Republic	-	Nigeria	-
Chad	-	Rwanda	-
Comoros	-	Sao Tome and Principe	-
Congo, Dem. Rep.	-	Senegal	0.39
Congo, Rep.	-	Seychelles	0.38
Cote d'Ivoire	-	Sierra Leone	-
Equatorial Guinea	-	Somalia	-
Eritrea	-	South Africa	0.93
Ethiopia	0.2	South Sudan	-
Gabon	0.6	Sudan	0.41
Ghana	-	Swaziland	-
Guinea	-	Tanzania	-
Guinea-Bissau	-	The Gambia	0.023
Kenya	-	Togo	-
Lesotho	0.03	Uganda	0.38
Liberia	-	Zambia	0.34
Madagascar	0.13	Zimbabwe	-

(Trading Economics, 2012) (World Bank, 2013)

Appendix B

Comparative country profile data on historical, geographic, social, political, and economic factors for Lesotho, Ethiopia, Zambia, and Botswana:

		LESOTHO	ETHIOPIA	ZAMBIA	BOTSWANA
Historical	**Colonial Power**	Great Britain	independent	Great Britain	Great Britain
	Year of Independence	1966	-	1964	1966
	International Environmental Agreements (party to)	Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Life Conservation, Ozone Layer Protection, Wetlands	Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Ozone Layer Protection	Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Wetlands	Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Wetlands
	International Environmental Agreements (signed but not ratified)	-	Environmental Modification, Law of the Sea	-	-
Geography	**Total Area (sq km)**	30,355	1,119,683	752,618	581,730
	Location	Southern Africa; landlocked; surrounded by South Africa	Eastern Africa; landlocked	Southern Africa; landlocked; the Zambezi forms a natural riverine boundary with Zimbabwe	Southern Africa; landlocked; population concentrated in eastern part of the country
	Bordering Countries	South Africa	Djibouti, Eritrea, Kenya, Somalia, Sudan	Angola, Democratic Republic of the Congo, Malawi, Mozambique, Namibia, Tanzania, Zimbabwe	Namibia, South Africa, Zimbabwe
	Climate	temperate; cool to cold, dry winters; hot, wet summers	tropical monsoon with wide topographic-induced variation	tropical; modified by altitude; rainy season	semiarid; warm winters and hot summers
	Terrain	mostly highland with plateaus, hills, and mountains	high plateau with central mountain range divided by Great Rift Valley	mostly high plateau with some hills and mountains	predominantly flat to gently rolling tableland; Kalahari Desert in southwest
	Land Use	arable land: 10.87%; permanent crops: 0.13%; other: 89%	arable land: 10.01%; permanent crops: 0.65%; other: 89.34%	arable land: 6.99%; permanent crops: 0.04%; other: 92.97%	arable land: 0.65%; permanent crops: 0.01%; other: 99.34%
	Natural Resources	water, agricultural and grazing land, diamonds, sand, clay, building stone	small reserves of gold, platinum, copper, potash, natural gas, hydropower	copper, cobalt, zinc, lead, coal, emeralds, gold, silver, uranium, hydropower	diamonds, copper, nickel, salt, soda ash, potash, coal, iron ore, silver
	Oil Production (Barrels per Day)	-	-	159	-
	Oil Proved Reserves	0 barrels	430,000 barrels	0 barrels	0 barrels
	Natural Hazards	periodic droughts	geologically active Great Rift Valley susceptible to earthquakes, volcanic eruptions; frequent droughts	periodic drought, tropical storms	periodic droughts; seasonal August winds blow from the west, carrying sand and dust across the country, obscuring visibility
	Environmental Problems	population pressure forcing settlement in marginal areas results in overgrazing, severe soil erosion, and soil exhaustion; desertification; Highlands Water Project controls, stores, and redirects water to South Africa	deforestation; overgrazing; soil erosion; desertification; water shortages in some areas from water-intensive farming and poor management	air pollution and acid rain in the mineral extraction/refining region; chemical runoff into watersheds; poaching of rhinoceros, elephant, antelope, and large cats; deforestation; soil erosion; desertification; lack of adequate water treatment	overgrazing; desertification; limited fresh water resources

		LESOTHO	ETHIOPIA	ZAMBIA	BOTSWANA
Politics	Type of Government	parliamentary constitutional monarchy	federal republic	republic	parliamentary republic
	Capital City	Maseru	Addis Ababa	Lusaka	Gaborone
	Status (2001)	partly free	partly free	partly free	free
	Status (2012)	partly free	not free	partly free	free
	Freedom Rating	3	6	3.5	2.5
	Civil Liberties	3	6	4	2
	Political Rights	3	6	3	3
	Suffrage	18 years of age; universal	18 years of age; universal	18 years of age; universal	18 years of age; universal
	Military Expenditures (% of GDP)	2.60%	3.00%	1.80%	3.30%
	Education Expenditures (% of GDP)	13.00%	6.00%	2.00%	8.70%
	R&D Expenditures (% of GDP)	0.03%	0.20%	0.34%	0.52%
	Public Debt (% of GDP)	-	44.50%	28.10%	5.40%
People	Population	2,130,819	85,237,338	11,862,740	1,842,323
	Population Growth Rate	0.12%	3.21%	1.63%	1.43%
	Net Migration/1000 Persons	-0.78	-0.02	-2.59	5.41
	Fertility Rate (Children/Woman)	3.06	6.12	5.23	2.66
	Infant Mortality/1000 Live Births	77.40	80.80	101.20	44.01
	Births/1000 Persons	24.41	43.97	40.52	22.96
	Deaths/1000 Persons	22.20	11.55	21.35	14.02
	Life Expectancy	40.38	55.41	38.63	50.16
	Literacy Rate	84.80%	42.70%	80.60%	81.20%
	HIV/AIDS Adult Rate	28.90%	4.40%	16.50%	37.30%
	HIV/AIDS Deaths	29,000	120,000	89,000	33,000
	Religions	Christian 80%, indigenous beliefs 20%	Christian 60.8% (Orthodox 50.6%, Protestant 10.2%), Muslim 32.8%, traditional 4.6%, other 1.8%	Christian 50%-75%, Muslim and Hindu 24%-49%, indigenous beliefs 1%	Christian 71.6%, Badimo 6%, other 1.4%, unspecified 0.4%, none 20.6%
	Ethnic Groups	Sotho 99.7%, Europeans, Asians, and other 0.3%	Oromo 32.1%, Amara 30.1%, Tigraway 6.2%, Somalie 5.9%, Guragie 4.3%, Sidama 3.5%, Welaita 2.4%, other 15.4%	African 98.7%, European 1.1%, other 0.2%	Tswana (or Setswana) 79%, Kalanga 11%, Basarwa 3%, other, including Kgalagadi and white 7%
	Labor Force by Occupation	subsistence agriculture: 86%; industry and services: 14%	agriculture: 80%; industry: 8%; services: 12%	agriculture: 85%; industry: 6%; services: 9%	-
	Unemployment Rate	45.00%	-	50.00%	7.50%
Economy	GDP	$2,430,000,000	$31,710,000,000	$19,210,000,000	$17,630,000,000
	GDP per Capita	$1,600	$700	$1,400	$14,300
	GDP Growth Rate	6.80%	11.60%	6.00%	4.80%
	Inflation Rate	8.00%	17.20%	10.60%	7.10%
	GDP Compositition by Sector	agriculture: 15.2%; industry: 45 %; services: 39.7%	agriculture: 47%; industry: 13.2%; services: 39.8%	agriculture: 17.4%; industry: 26.1%; services: 56.5%	agriculture: 1.6%; industry: 51.5%; services: 46.9%
	Industries	food, beverages, textiles, apparel assembly, handicrafts, construction, tourism	food processing, beverages, textiles, leather, chemicals, metals processing, cement	copper mining and processing, construction, foodstuffs, beverages, chemicals, textiles, fertilizer, horticulture	diamonds, copper, nickel, salt, soda ash, potash; livestock processing; textiles

		LESOTHO	ETHIOPIA	ZAMBIA	BOTSWANA
Economy (cont'd)	**Agricultural Products**	corn, wheat, pulses, sorghum, barley; livestock	cereals, pulses, coffee, oilseed, cotton, sugarcane, potatoes, qat, cut flowers; hides, cattle, sheep, goats; fish	corn, sorghum, rice, peanuts, sunflower seed, vegetables, flowers, tobacco, cotton, sugarcane, cassava (tapioca), coffee; cattle, goats, pigs, poultry, milk, eggs, hides	livestock, sorghum, maize, millet, beans, sunflowers, groundnuts
	Imports	$1,880,000,000	$5,165,000,000	$3,611,000,000	$3,403,000,000
	Exports	$956,000,000	$1,288,000,000	$4,594,000,000	$5,025,000,000
	Import Commodities	food; building materials, vehicles, machinery, medicines, petroleum products	food and live animals, petroleum and petroleum products, chemicals, machinery, motor vehicles, cereals, textiles	machinery, transportation equipment, petroleum products, electricity, fertilizer; foodstuffs,	foodstuffs, machinery, electrical goods, transport equipment, textiles, fuel and petroleum products,
	Export Commodities	manufactures 75% (clothing, footwear, road vehicles), wool and mohair, food and live animals	coffee, qat, gold, leather products, live animals, oilseeds	copper/cobalt 64%, cobalt, electricity; tobacco, flowers, cotton	diamonds, copper, nickel, soda ash, meat, textiles
	Export Partners	US 71.5%, Belgium 25.6%, Canada 1.2%	Germany 8.2%, Saudi Arabia 7%, US 6.9%, Djibouti 6.6%, China 6.5%, Italy 6.5%, Japan 5.9%, Netherlands 4.8%	Switzerland 41.8%, South Africa 12%, Thailand 5.9%, Democratic Republic of the Congo 5.3%, Egypt 5%, Saudi Arabia 4.7%, China 4.1%	European Free Trade Association (EFTA) 87%, Southern African Customs Union (SACU) 7%, Zimbabwe 4%
	Central Bank Discount Rate	12.82%	-	11.73%	14.50%

(CIA, 2008)(Freedom House, 2012)